Direct Detection of BLIMP Dark Matter with Laser Interferometry: The HINDENBERG Experiment

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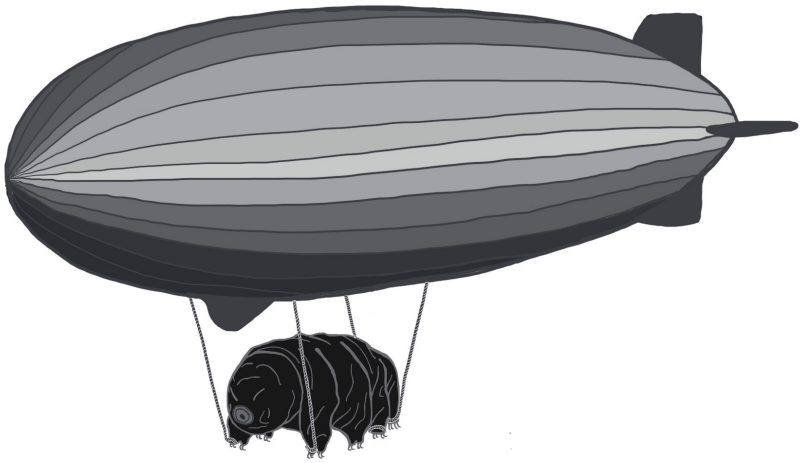
Concept

- Suppose, as proposed in the session yesterday, dark matter is composed of electron-mass blimps constructed by asteroid-bound tardigrades (water bears) while waiting in stasis to arrive on a planet
  - BLIMP: waterBear Laid Inertially-steered Massive Particle

- We expect these BLIMPs to be somewhat reflective, which should act as a small fractional charge

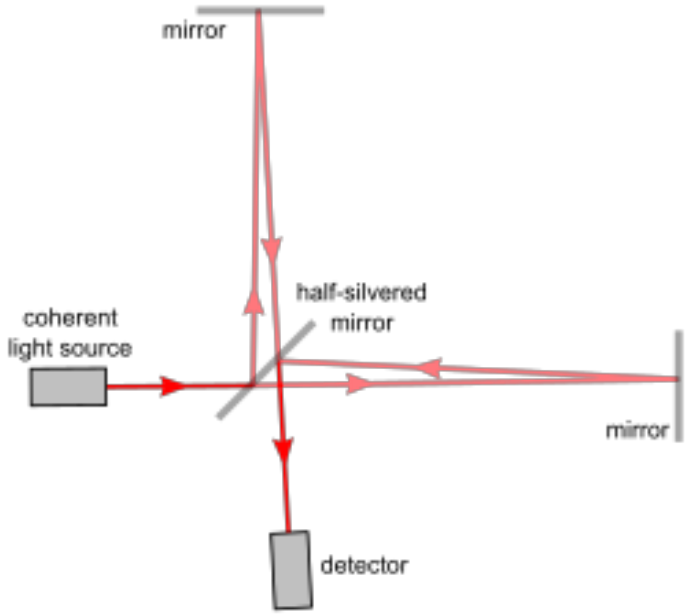
- We propose to operate a meter-scale interferometer at the bottom of the Marianas trench (for significant water overburden) to detect photon deflections caused by these BLIMPs

- A signal of dark matter would be spontaneous de-tuning of this interferometer, the rate of which depends on the orientation with the BLIMP wind



Detection Technique

- The laser is tuned to the dark fringe, with a short and long arm such that one laser path passes through a larger volume of BLIMPs
- The event rate is modulated by the motion of the earth as the arms are aligned relative to the BLIMP wind
- A high quantum efficiency, single photon counting sensor is used to detector single photon deficiencies; even in the shot-noise limit, long-term trends in deviation from perfect cancellation between the two arms will be detectable through fitting to daily and yearly cycles
- The ultimate sensitivity, in the background-free limit, depends on the quantum efficiency of the beam-splitter, mirrors, and detector. We also need a laser with very long coherence length.
- For conventional technologies, this is not possible; we rely on the development of meta-materials and advanced lasers to produce pairs of perpendicularly polarized photons, such that when a photon is deflected by a BLIMP, the deficit can be traced to a given arm

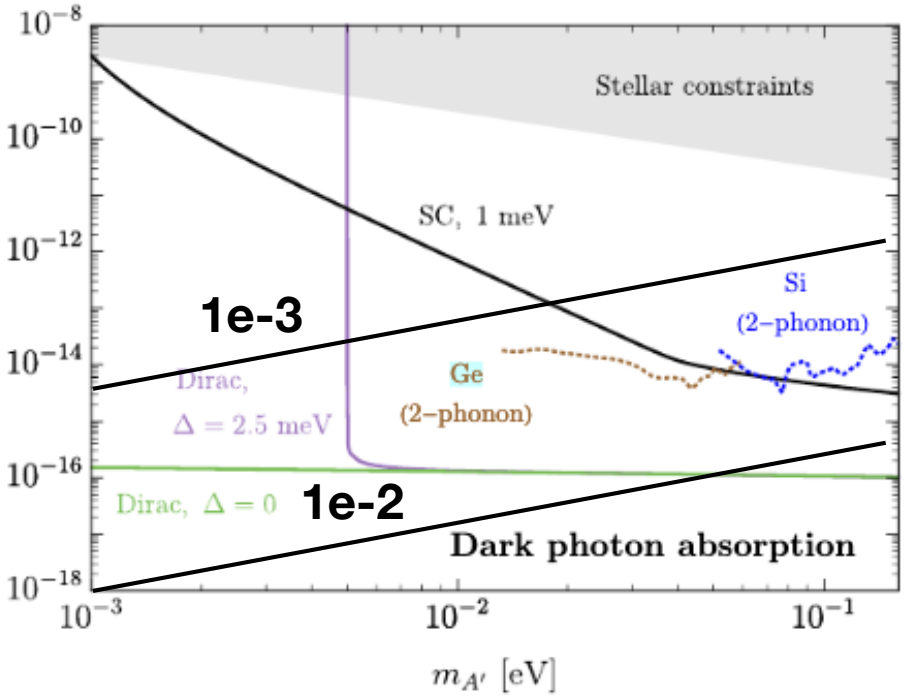


BLIMP Sensitivity

- Limits for BLIMP dark matter as a function of mass shown for 1 year integrations for missing photon detection efficiencies of 1e-3 and 1e-1
  - We do not claim to be able to perfectly detect missing photons due to realistic quantum efficiency limitations

- This of course assumes a background-free search; any particle constitutes a background.
  - We particularly worry about neutron and neutrino crossings in the detector given that they cannot be shielded by a large external magnetic field

- Ultimate sensitivity reached when photon coupling is weaker than random detuning from subduction events.



Status of R&D

- Pairwise correlated photon laser
  - Under development by Dr. Loompa at W. Wonka Technical Institute
  - 50% photon correlation currently achieved

- High quantum efficiency meta-material mirrors and beamsplitters
  - Fox Group at Wayne Industries
  - Should show up about 45 minutes into the movie

- Background assays: PNNL

- Development of shielding, vacuum vessel, and readout
  - Collaborators wanted!

Future Prospects

- Initial pathfinder experiment, HINDENBERG, scheduled for summer 2025
  - Technology demonstrator and week-scale sensitivities
- Full-scale experiment, LedZeppelin, built on the remains of HINDENBERG whenever it flames out, likely 2025
- Pathfinder funding provided by an unexpected hole in Fred Kavli's pocket
- Future funding contingent on successful operating of HINDENBERG for one full operating period